Physics w/ Calculus Course Number: Phys 201 Fall 2025
3 Hours

Instructor: Andrew Beane

E-Mail: abeane@walsh.edu

**andy.beane@lepapps.org (preferred)**

Meeting Day: Tues/Thurs

Time: 6:45-9:15 P.M.

Room:

This course is an introduction to the fundamental principles of classical mechanics and thermodynamics, designed for science and engineering majors. The course covers topics including kinematics, dynamics, Newton's laws, energy, momentum, rotational motion, oscillations, and waves, as well as an introduction to thermodynamics and heat transfer. Emphasis will be placed on the use of calculus to solve real-world problems and analyze physical systems.

Through lectures, problem-solving sessions, and laboratory experiments, students will explore the mathematical modeling of physical systems and develop critical thinking skills necessary for understanding and applying physics concepts. This course is designed to foster an in-depth understanding of motion, forces, and energy, providing a solid foundation for more advanced studies in physics and engineering.

**Key Topics:**

- Motion in one and two dimensions
- Newton's laws of motion
- Forces, including friction, tension, and gravitational forces
- Work, energy, and the work-energy theorem
- Impulse and momentum
- Rotational motion and dynamics
- Simple harmonic motion and waves
- Heat, temperature, and the laws of thermodynamics

**Learning Outcomes:** Upon completion of this course, students will be able to:

- Apply calculus-based methods to analyze and solve problems in mechanics and thermodynamics.
- Understand and utilize the fundamental laws of physics to explain the behavior of physical systems.
- Conduct experiments, analyze data, and communicate scientific results effectively.
- Relate physical concepts to real-world phenomena, particularly in engineering and technological contexts.

**Grading**

| | |
|---|---|
| ● A 100-93, A- 92.99-89.5,<br>● B+ 89.49-87, B 86.99-83,<br>B- 82.99-79.5, | ● C+ 79.49 -77, C 76.99-73, C-<br>72.99-69.5,<br>● D+ 69.49-67, D 66.99-63, D- 62.99-60,<br>F< 60 |

Your final grade will be based on three exams and one final, weekly quizzes, as well as additional assignments and activities.

**Exams** 45% of your final grade. Exams will be held during the regular class time and be online. You must have a way to access the exam. Each Exam will be 20-40 questions

**Assignment/HW/Labs** 40% of your final grade. Assignments will consist of activities given in class. The assignment should be typed or neatly written, with your name and the date in the upper right corner and all pages stapled together. Assignment scores will be out of ten points. Some assignments may count double.

**Final Exam** 15% of your final grade. It will be a comprehensive, closed book, and closed notes.

Students' responsibilities:

If you are ill do not come to class. Contact me to let me know you will not be attending in advance. You will still be responsible for the material for that class meeting.

- Keep in touch with the instructor regarding questions and concerns
- Be to class on time
- Read assigned materials for class
- Take notes in class
- Complete assignments and turn them in on time
- Prepare for your exams by rereading the assignments, reviewing your notes and quizzes, and reviewing the questions at the end of each chapter in the book

Accessibility Services for Students with Disabilities

Walsh University is committed to fostering an institutional climate in which qualified students with disabilities have full access to the academic environment. However, please be advised that it is your responsibility to arrange accommodations and failure to do so in a timely manner may have a negative impact on your academic success.

If you feel that you may need an accommodation based on the impact of a disability, please contact Meredith Soduk, Director of Accessibility Services, at 330-490-7529 or msoduk@walsh.edu to begin delivery of services as soon as possible. Once your eligibility for services is determined, your instructors will be provided a letter which will outline your accommodations. If you believe you may have a disability and would like to learn more about disability-related services, please contact The Office of Accessibility Services, located in Farrell Hall 209, immediately.

# Tentative Course Calendar

*This schedule is subject to change at the instructor's discretion.*

| Week | Session | Date | Topic / Activity |
|---|---|---|---|
| **1** | 1 | Oct 21 | **Intro to Physics:** Units, Dimensions, 1D Kinematics with Calculus |
| | 2 | Oct 23 | Constant Acceleration, Free-Fall, Integration in Kinematics |
| **2** | 3 | Oct 28 | **Vectors:** Vector Algebra, Components, and Unit Vectors |
| | 4 | Oct 30 | **2D Kinematics:** Projectile Motion & Uniform Circular Motion |
| **3** | 5 | Nov 4 | **TEST 1 (Kinematics: Weeks 1-2)** |
| | 6 | Nov 6 | **Dynamics:** Newton's First & Second Laws, Free-Body Diagrams, Newton's Third Law, Friction, and Applications (Inclines, Pulleys) |
| **4** | 7 | Nov 11 | **Work & Energy:** Work-Energy Theorem, Work done by a Variable Force |
| | 8 | Nov 13 | Class Activities will be posted online(NO in class session) |
| **5** | 9 | Nov 18 | Potential Energy, Conservative Forces, Conservation of Energy |

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|---|---|---|---|
| | 10 | Nov 20 | **Momentum:** Linear Momentum, Impulse, and Collisions |
| **6** | 11 | Nov 25 | **TEST 2 (Dynamics, Work/Energy, Momentum: Weeks 3-5)** |
| | - | Nov 27 | **No Class - Thanksgiving Holiday** |
| **7** | 12 | Dec 2 | **Rotational Motion:** Rotational Kinematics and Dynamics |
| | 13 | Dec 4 | Torque and Moment of Inertia |
| **8** | 14 | Dec 9 | **Oscillations & Gravitation:** SHM, Pendulums, Universal Gravitation, Final Review |
| | 15 | Dec 11 | **FINAL EXAM (Cumulative, emphasis on material after Test 2)** |

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Learning Objectives:

1. **Kinematics and Dynamics:**
    - **Apply** calculus-based techniques to solve problems involving rectilinear and curvilinear motion in one and two dimensions.
    - **Analyze** velocity and acceleration as derivatives of position and velocity functions, respectively.
    - **Solve** real-world problems involving motion under constant and non-constant acceleration using kinematic equations and calculus.
    - **Demonstrate** an understanding of Newton's laws of motion and their applications to forces in both rectangular and curvilinear coordinates.
2. **Forces and Newton's Laws:**
    - **Construct** free-body diagrams to analyze forces acting on objects in static and dynamic scenarios.
    - **Apply** Newton's laws to systems involving friction, tension, normal forces, and gravitational forces, and solve complex problems involving multiple forces.
    - **Analyze** centripetal forces in circular motion and relate them to tangential and radial acceleration.
    - **Explore** advanced dynamics concepts like systems of particles and variable mass systems.
3. **Gravitational Forces:**
    - **Understand** the universal law of gravitation and **apply** it to the motion of celestial bodies and satellite orbits.
    - **Use** Newton's law of gravitation in conjunction with Kepler's laws to predict planetary motion.
    - **Solve** problems involving gravitational potential energy and forces in gravitational fields.
4. **Work, Energy, and Power:**
    - **Apply** the work-energy theorem to systems involving conservative and non-conservative forces.
    - **Analyze** the conservation of mechanical energy in closed systems.
    - **Solve** problems involving power, work, kinetic energy, and potential energy in real-world scenarios.
    - **Use** calculus to compute work done by variable forces along curved paths.
5. **Momentum and Impulse:**
    - **Understand** the concept of momentum and **apply** the impulse-momentum theorem to various systems.
    - **Analyze** collisions (elastic and inelastic) using the conservation of momentum.
    - **Solve** problems involving the center of mass and motion of systems of particles using calculus.
6. **Oscillatory Motion and Waves:**
    - **Explore** simple harmonic motion (SHM) and **derive** its equations using differential calculus.

- **Analyze** systems undergoing SHM, such as springs and pendulums, and solve problems involving oscillatory motion.
- **Understand** the properties of wave motion, including wavelength, frequency, and speed, and **apply** these to both mechanical and sound waves.
- **Analyze** the Doppler effect and its applications in various physical contexts.

7. **Thermodynamics and Kinetic Theory:**
   - **Understand** the kinetic theory of gases and **apply** the ideal gas law in various thermodynamic processes.
   - **Analyze** processes of heat transfer (conduction, convection, and radiation) and their real-world applications.
   - **Explore** the concepts of specific heat, latent heat, and phase changes, and **solve** calorimetry problems involving heat energy.
   - **Apply** the first and second laws of thermodynamics to closed systems and heat engines.
8. **Advanced Topics in Heat and Energy:**
   - **Analyze** the behavior of gases under changes in temperature, pressure, and volume, using calculus to model thermodynamic processes.
   - **Understand** the change of state and **calculate** the energy involved using phase diagrams.
   - **Solve** problems involving calorimetry, including heat transfer and energy conservation during phase changes.
9. **Problem-Solving and Mathematical Skills:**
   - **Develop** critical thinking skills through complex problem-solving involving calculus, algebra, and trigonometry.
   - **Use** integration and differentiation to model and solve physics problems involving motion, forces, energy, and waves.
   - **Interpret** data and graphs related to motion, forces, energy, and thermodynamic processes.
10. **Communication and Experimentation:**
    - **Design** and conduct experiments to test and validate physical principles related to motion, forces, energy, waves, and thermodynamics.
    - **Analyze** experimental data using statistical and graphical methods, and **communicate** findings through reports and presentations.
    - **Collaborate** effectively in teams to solve complex physical problems and complete laboratory experiments.